Research Note

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UTILIZATION OF LODGEPOLE PINE LOGGING RESIDUES IN WYOMING INCREASES FIBER YIELD

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ABSTRACT

*Near complete harvesting in mature Wyoming lodgepole pine (*Pinus contorta *Dougl.) resulted in a 35-percent increase in weight of fiber removed compared to conventional harvesting.*

Because of the large volume of residues (tops, branches, dead and defective stems) that remain after most logging operations, land managers are forced to expend monies in many forest types for slash disposal to reduce fire hazards and for site preparation treatments to insure regeneration. Consequently, they have long sought alternative harvesting methods that would not only result in reducing the volume of residues remaining on the logged site but also increase the utilization of this material in the form of wood fiber yields.

Information regarding wood fiber yield is now available from the use of one such alternative harvesting method in a study currently being conducted by the Station in cooperation with U. S. Plywood-Champion Papers, Inc., and the USDA Forest Service, Intermountain Region. In this study, long-term effects of this method on ecological factors are being evaluated: namely, on regeneration, nutrient cycling, wildlife, esthetics, and hydrology. Hopefully, this pilot study also will provide cost-benefit information as well as some guidelines as to how similar studies should be conducted in the future.

Unlike what occurs in typical harvesting operations, the volume data presented in this report are based on measurements taken before and after harvesting in addition to the volume that was harvested. It should be borne in mind that this study involves only one species and one stand condition. Thus, these data are not necessarily applicable to other logging operations.

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STUDY PROCEDURE

Two lodgepole pine (*Pinus contorta* Dougl.) stands near Union Pass on the Teton National Forest in western Wyoming were selected for study. Each was relatively homogenous with respect to number, size, and spatial distribution of trees.

Within each of these stands, a study block was established, which was divided into two harvesting units. One harvesting unit was clearcut according to "conventional" standards, and the other unit was clearcut using new standards, which we chose to term "near complete" harvesting. Both the "conventional" and "near complete" standards called for the removal of all sound trees to a merchantable top diameter of 6 inches. In addition, the "near complete" standards required on-the-site conversion to chips of (1) tops of all merchantable trees; (2) all remaining standing trees with a d.b.h. of 3 inches or larger, including sound dead trees; and (3) all sound dead material remaining on the ground that was more than 6 inches in diameter at the larger end and that was more than 6 feet long.

How Measurements Were Taken

Measurements taken before the four units were harvested produced estimates of (1) stand volume, (2) number of trees, (3) site index, and (4) the volume of wood material lying on the ground (table 1 and fig. 1). A systematic sample grid served as the basis for selecting the locations that were measured, using a random start. The number of locations so selected in each unit follows:

Unit 1, "near complete" harvest	25
Unit 2, "conventional" harvest	31
Unit 3, "conventional" harvest	33
Unit 4, "near complete" harvest	39

Each location consisted of three plots superimposed on each other: (1) a variable plot, on which a 40-BAF angle prism was used to measure trees 5.0 inches d.b.h. and larger; (2) a 1/300-acre fixed plot on which all trees less than 5.0 inches d.b.h. were measured; and (3) a 50-foot transect[2] along which ground material 3 inches in diameter and greater was measured. One tree was measured on each location for determination of site index.

After harvesting, a systematic sample grid of twenty 50-foot transects was used in each unit to estimate the volume of material 3.0 inches in diameter and greater remaining on the ground (see table 1).

WEIGHT AND VOLUME OF MATERIAL HARVESTED

The weight of the logs harvested was obtained by weighing the loaded trucks; the weight of the chips harvested by measuring the volume of chip piles using aerial photogrammetric techniques and applying a conversion factor of 14.4 lb./cu.ft. (table 2). There was no significant difference between blocks or between treatments in total tons (unadjusted) per acre removed as the following analysis of variance (ANOVA) shows:

Source	*df.*	*SS*	*MS*	*F ratio*
Blocks	1	113.423	113.423	0.0850^{NS}
Treatment	1	1,159.403	1,159.403	.8688^{NS}
Error	1	1,334.448	1,334.448	

[2]James K. Brown. A planar intersect method for sampling fuel volume and surface area. Forest Sci. 17(1): 96-102. 1971.

Table 1.--*Description of study stands before and after harvesting*

Item	Block 1: Unit 1 Treatment: near complete harvesting	Block 1: Unit 2 Treatment: conventional harvesting	Block 2: Unit 3 Treatment: conventional harvesting	Block 2: Unit 4 Treatment: near complete harvesting
Area of unit (acres)	16.8	21.7	22.5	17.2
Average stand age	168.7	166.0	185.4	178.0
Average site index (50-yr. base)	43.7	42.7	39.9	41.8
Volume/acre to 6-in. top of live standing trees (cu.ft.)	5,912	7,167	6,131	5,182
Volume/acre to 6-in. top of dead standing trees (cu.ft.)	1,014	1,016	1,120	1,064
Total volume/acre to 6-in. top (cu.ft.)	6,926(±621)[1]	8,183(±580)	7,251(±555)	6,246(±452)
Volume/acre of tree residuals[2] (cu.ft.)	1,124(±205)	1,460(±252)	797(±132)	752(±105)
Volume/acre of ground material ≤ 3 in. in size (cu.ft.)	1,820(±308)	1,182(±175)	1,478(±237)	2,482(±315)
Preharvest total volume/acre (cu.ft.)	9,870(±723)	10,825(±656)	9,526(±618)	9,480(±561)
Postharvest volume/acre of ground material ≤ 3 in. (cu.ft.)	564(±118)	3,589(±378)	3,545(±536)	894(±331)

[1]Figures in parentheses are 68-percent confidence intervals.
[2]Tree residuals is the difference between total volume for trees 3.0 in. d.b.h. and larger, and merchantable volume to a 6-in. top for trees 6.5 in. d.b.h. and larger.

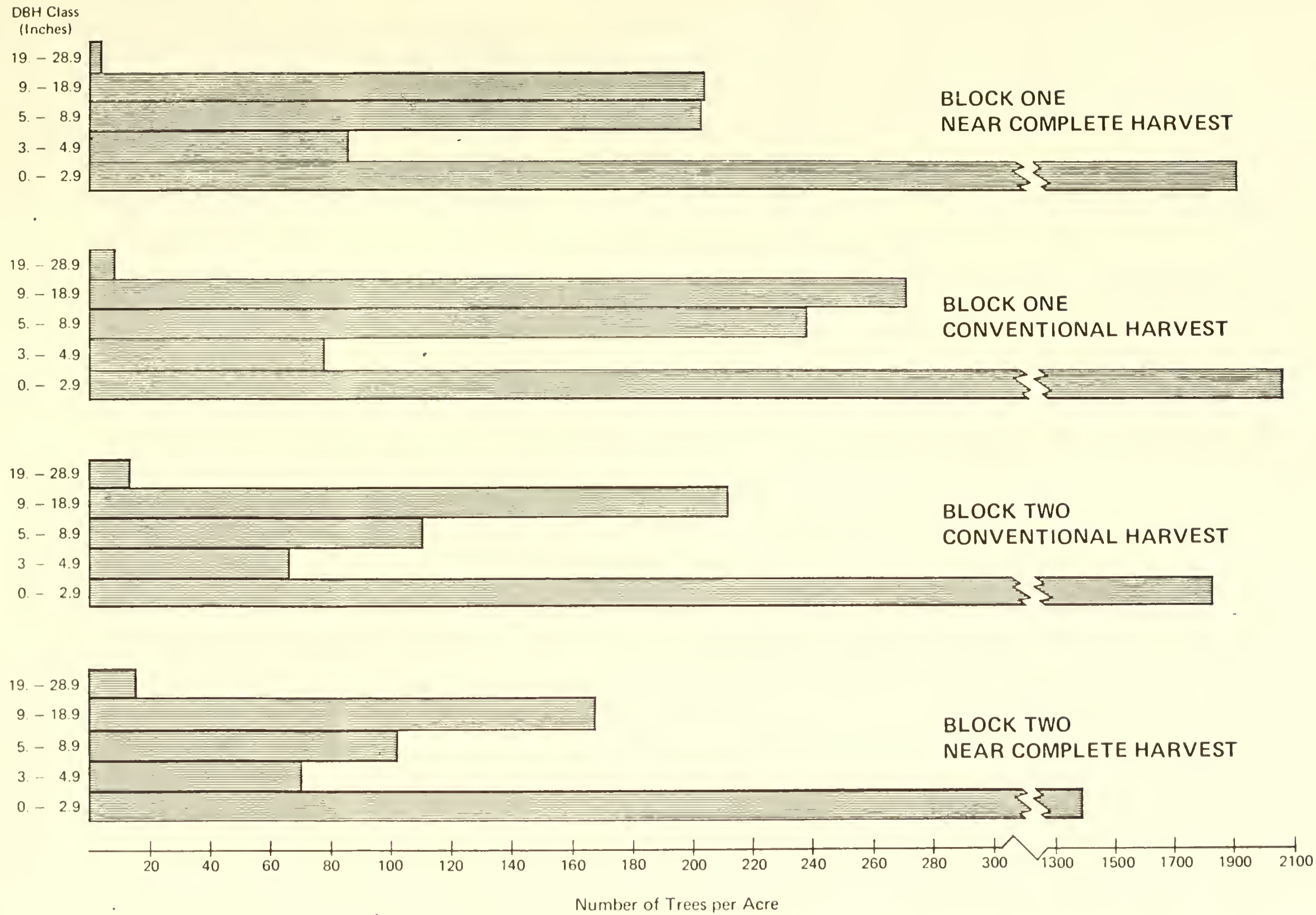

Figure 1.--Number of trees per acre by d.b.h. class.

Table 2.--*Volumes and weights (green) per acre of wood removed from study stands*

Harvest type	Unit No.	Merchantable logs		Chips		Unadjusted total weight	Adjusted total weight
		MBF	*Tons*	*Cu.ft.*	*Tons*	*Tons*	*Tons*
BLOCK 1							
Near complete	1	14.7	70.8	11,780	84.9	155.7	163.2
Conventional	2	25.1	129.5	0	0.0	129.5	123.8
BLOCK 2							
Conventional	3	21.4	111.0	0	0.0	111.0	110.7
Near complete	4	15.2	74.9	10,700	78.0	152.9	153.3

This result was not surprising; the experimental design necessitated an extremely large and consistent difference between treatments to be statistically significant. However, the difference could be of practical importance.

To permit reasonable comparison between treatments, differences in weight removed were adjusted for preharvest total volume differences on the four units. For each block, the difference between the preharvest total volume estimate on a treatment unit and the average preharvest total volume estimate was calculated and expressed as a proportion of the preharvest total volume on the treatment unit. This average was then applied as a correction factor to the original estimates of the weights of wood harvested from the units (table 2). These adjusted weights were then averaged as follows:

	Tons/acre
Average of adjusted weights of material removed from units 1 and 4	158
Average of adjusted weights of material removed from units 2 and 3	117
Difference	41
Percent difference	35

DISCUSSION AND CONCLUSIONS

Harvesting to the "near complete" removal standards resulted in retrieval of 35 percent more fibre than when conventional harvest standards were used.

The difference in merchantable weight of logs actually harvested (table 3) between the two treatments cannot be explained by differences in live merchantable volume that was measured before harvesting. We believe this difference might be largely attributable to our observation that some merchantable logs were chipped inadvertently. This occurred because the tree-length logging requirements imposed for the study made it impossible to cut merchantable sections out of green trees having rotten butts. Moreover, the more stringent standards posed problems for the crews. Future studies should be designed to have tighter controls over what material will be chipped and what will be removed as logs.

Table 3.--*Comparison of preharvest merchantable volume estimates of live standing trees with actual weight of merchantable logs removed from study blocks*

Harvest type	Unit No.	Inventoried volume (to 6-in. top)	Difference	Actual weight	Difference
		Cu.ft./acre	*Percent*[1]	*Tons/acre*	*Percent*[1]
BLOCK 1					
Near complete	1	5,912	17.5	70.8	45.3
Conventional	2	7,167		129.5	
BLOCK 2					
Conventional	3	6,131	15.5	111.0	32.5
Near complete	4	5,182		74.9	

[1] $\frac{\text{Conventional-Near complete}}{\text{Conventional}} \times 100.$